The Builder.

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SATURDAY, SEPTEMBER 18, 1847.

IN April, 1844, ten commissioners were appointed by Government to inquire into the most eligible situation for a harbour of refuge in the channel,* and in the month of August in the same year, they reported in favour of Dover. In the following year the constitution of the commission was slightly altered,† and they took further into consideration, amongst other important points, the mode of constructing the proposed harbour, and the materials to be used. The commissioners examined many witnesses, and at the commencement of 1846, recommended, in respect of the points we have named, that the inclosure of the proposed harbour should be formed by *a wall nearly upright*, and said masses of brick in cement might be used for it below low-water mark, with granite or hard stone above. The following are the words of the report:—

"Practical illustrations, together with the weight of evidence bearing on the subject, lead us to an unhesitating recommendation of a wall nearly upright, to form the inclosure of the harbour proposed to be constructed in Dover Bay.

With respect to the description of material to be employed, we have had to consider the very serious difficulties arising out of the want of stone of a suitable quality in the neighbourhood of Dover. If granite could be procured of the required dimensions in sufficient quantity, and with ordinary facility, it would undoubtedly be the proper material to use.

Portland and the Channel Islands have been pointed out as the places from whence supplies of stone may be obtained; but both are at a considerable distance from Dover; and the delay that might occur in the supply will be obvious. Several of the engineers have in consequence recommended concrete in blocks, or masses of hard brick in cement, as substitutes for stone; the former on the supposition of its cheapness.

We think, however, there is not sufficient experience of the use of concrete, to warrant its adoption for the faces of works to be constructed in the sea.

We are of opinion that, if stone cannot be readily procured, masses of brick of a proper quality, laid in cement, may be used for all purposes below low-water mark, with perfect confidence in the strength and durability of this material; but that above water, granite or hard stone will be necessary.

We do not enter into any detailed specification of the plan and dimensions of the piers, which will be the duty of the engineer who may be employed. Their breadth will have to be determined by the space required for quays, coaling stations, and for general mercantile convenience. We consider that the interior or hearting may be composed of rubble and concrete; and we would strongly recommend that the work be commenced at as many points as practicable, at the same time."

Two of the commissioners, Sir Howard Douglas and Sir William Symonds, refused to sign this report; the first on the grounds, amongst others, that he considered the building of an *upright* wall in the open sea, in seven or eight fathoms water, was a proposition novel in theory and not proved in practice, on any scale to warrant its adoption, and was decidedly opposed "to the employment of any artificial or inferior material, as a substitute for stone, from mere considerations of pecuniary economy;" those, he thought, should have no place in a great national undertaking, "which, if not to be constructed on sound and well-tried principles, with materials of the best and most enduring descriptions, should not be attempted." He was of opinion, that a breakwater of the proposed elevation and magnitude, rising, with an upright face, from the depth of 42 feet at low water, would be far less capable of resisting the violence of seas than a sloping breakwater, formed in a manner similar to that which has been completed in Plymouth Sound.* The second objector concurred in both these grounds of dissent, and, further, was opposed to Dover as the site of the harbour.

This large work, if carried out, would involve the expenditure of some millions of money, and the efficient execution of it is necessarily a matter of great moment. It is not our present purpose, however, to discuss the soundness of the recommendations contained in the report. The reasons of the dissentients have been printed, by order of the House of Commons, and the matter must of course receive further and most serious consideration. The question of building an upright wall in lieu of a sloping breakwater, must be discussed more profoundly and severely than has yet been done, before the work be attempted.

Throughout the evidence are scattered opinions and information on the subject of concrete and other materials used in construction, and our present object is, simply to abstract these for the benefit of our readers. We take the evidence in the order in which it stands, accompanying the report of January, 1846.

Capt. Denison, R.E., the first witness, in reply to the inquiry—"In the letter written by Colonel Jones and yourself to the Admiralty, you allude to the experience of other nations in the use of concrete for centuries. What are the particular works which afford this length of experience?"—said,—"In answer to that question, I think I had better refer the commissioners to the prize essay by Mr. Godwin, upon the nature and properties of concrete, and its application to construction up to the present time, which was published in the Transactions of the Institute of British Architects. In this work many instances are recorded where concrete was used by the ancients: Vitruvius is quoted, and a variety of others, who have written upon the subject, all of whom testify strongly in favour of this material.

Can you briefly mention the places, and what the works were?—At Richborough Castle, in Kent, many of the walls, which are of Roman workmanship, are filled in with concrete. The foundations of Salisbury Cathedral are laid in concrete; that of the north transept of Westminster Abbey the same; and the walls of some of the fortresses in Spain bear strong evidence to the solidity which a mass of concrete can attain in time; they were found more difficult to breach than walls built of stone, and may be said to have required to be pounded to pieces. Belidor, in his Architecture Hydraulique, strongly recommends this material for foundations."

"Do you know any instance of masses of brickwork, with cement, being used for submarine works in exposed situations?—No, I do not know an instance; but I do not see that there can be any difficulty in constructing them.

And, in fact, you consider them as substantial and as good for the purpose as concrete, except the expense?—Yes: the difference in the cost is my only reason for preferring concrete to brickwork.

(*Sir William Symonds.*)—What is the specific gravity?—The specific gravity is rather less. Concrete weighs about 140 lbs. to the cubic foot, and brickwork about 110.

What is granite and Portland stone?—Granite weighs from 160 to 170; Portland stone about 150 lbs. to the cube foot."

(*Sir Howard Douglas.*)—"You propose to build a perfectly upright wall from the bottom?—Yes.

With concrete *blocks* up to low-water mark?—Yes.

And you have no doubt that concrete will resist the action of the water below, and that it will not be undermined nor worn away by the shingle which would roll along the foot of the wall?—There is no rolling with a vertical wall.

You have no doubt that it would not be undermined by the action of the current, but that it would stand; and you would bring up the concrete wall to low-water mark?—Yes; and above that I would build it with granite.

You have no doubt of the power of concrete to bear that immense superincumbent weight?—I have no doubt, both from my own experience and the experience of others.

You are prepared, as an engineer, to recommend this use of concrete?—I am.

What are the ingredients?—I think the best material we can have is the gravel with sea beach, if it contains a sufficient quantity of sand; this should be mixed with the best hydraulic lime we can get, in the proportion of ten or twelve of gravel to one of lime; and with the view of causing it to set more speedily under water, a proportion of puzzolana should be added, varying in quantity according to its quality; half the quantity of puzzolana that there is of lime will make very hard sound concrete, which will set rapidly; and in cases where it is desirable that it should set very quick, the quantity may be increased till it equals that of the lime.

Those are pretty nearly the proportions of the ingredients that have been used for some time?—Pretty near; there is an increase in the shingle; there is less lime in proportion to the shingle, and a proportion of puzzolana is added."

The concrete wall at Woolwich had bearing piles, "because the foundation was mud and peat. The sheet piles were 10 feet apart, and were connected from distance to distance by iron ties. Concrete was then thrown in on the soft mud; it was thrown in *en masse*, till it came up to the level of the wall, and upon that foundation the blocks of concrete were built, and concrete again filled in in the rear of them. That wall is now quite hard. The foundation part, which was thrown into the water, is quite hard. I had occasion, three or four years ago, to cut into it, and I found it quite hard. I have built a large chimney, 210 feet high, at Woolwich. The weight on the foundation is at least 3,000 tons; the foundation is a stratum of concrete upon chalk, and the weight is fully three tons upon the foot superficial."

"With reference to this wall (Woolwich), I did doubt its durability; I thought it was soluble in water, that the constant action of the water would act chemically on the mass, and wear it away.

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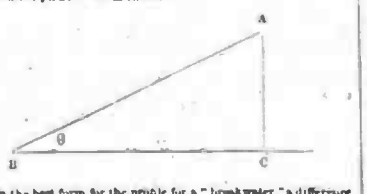
* Admiral Sir Byam Martin, Chairman, Lieutenant-General Sir Howard Douglas, Bart., Rear-Admiral Deans Dundas, Sir J. H. Pelly, Bart., Captain Sir W. Symonds, Captain Washington, Lieutenant-Colonel Colquhoun, Lieutenant-Colonel Ahlerwin, Captain Fisher, and Mr. James Walker.

† Captain Beaufort and Captain Brandreth took the places of Captain Fisher and Mr. Walker.

* "The application of the theory of the resistance and impact of fluids is no doubt attended with great difficulties and anomalies in this, as in many other cases connected with natural philosophy; but whatever results have been derived, either from theory or observation, they all agree in this, that the horizontal impulse of a fluid on any resisting body is increased, in a very high ratio, as the inclination of its surface (AB) to the direction (BC) of the motion increases. The fundamental theorem is, that this varies as sin. θ^2, θ representing the inclination. Because the height of the breakwater continuing the same, the quantity of fluid impinging on it will be the same at all inclinations. If the height of the breakwater were variable, the whole impetus would then be as sin. θ^2, because in this case, not only is the force of each particle diminished in proportion to sin. $\angle\theta$, but the number of particles which impinge on the plane varies as sin. θ."



"On the best form for the profile for a "breakwater," a difference of opinion exists; and while, on one hand, it is contended that the exterior face of the wall should be vertical, on the other, a face inclined to the horizon is recommended. The advocates of the former construction seem to consider that such a wall is subject only to the hydrostatical pressure of a fluid at rest, or that the agitations of the water before it, take place only in vertical directions; but neither of these conditions holds good in Dover Bay, or wherever, by the force of winds and currents, the waves are impelled with violence against the shore. That loose stones constituting a breakwater, when deposited so as to form an inclined plane, should be occasionally displaced by the action of waves is sufficiently obvious; but that, with equal quantities of material, a vertical wall should resist the concussions produced by such action, as effectiously as one with an exterior slope, is inconceivable," says the dissentient.